Virtual Reality Solutions for Sports Training Data Management with 5G UWB Communication Technology and Wearable Devices

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Abstract. In recent years, the development of sports in China has received widespread attention, and sports culture has gradually come to life, making the selection of Olympic reserves from young people an urgent priority. In order to select sports teams for young people in a fair and impartial manner, the idea of "digital sport" has been gradually introduced into sports training, combining the increasingly mature information technology and network technology, using sensors to monitor posture information, making training and selection parametric, scientific and digital. Therefore, this paper firstly investigates the ultra-bandwidth technology of antennas as a key 5G technology, processes and tests the proposed monopole antenna from the most basic planar monopole structure, proposes a wearable digital sports training system based on MEMS sensors, and proposes solutions for the accuracy of training movements, scientific training methods and early warning analysis of joint injuries. Experimental test results show that the MEMS sensor-based sports-assisted training system can not only increase the number of sports-assisted training methods but also improve coaching efficiency, thus greatly improving the performance of the sports-assisted training system. The design system in the paper is of great significance to the promotion of motion capture technology and its application in the field of assisted training.

Keywords: digital sports; coplanar waveguide; MEMS; Virtual Reality Solutions.
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1 INTRODUCTION

Since the twentieth century, information and information technology has developed rapidly and the information age has officially arrived. People cannot live without information and information technology in all aspects of their working lives, including clothing, food, housing and transport, fitness, and medical care [13]. The traditional information dissemination method has developed into a modern information dissemination method that incorporates computer technology, software technology, network technology, data management technology and communication technology [4]. With the rapid development of network technology, the trend is to use the network as a carrier to process, produce and disseminate information including: current affairs, electronic publications, images and texts, video and audio, etc. The advantages over traditional methods of communication are obvious. Therefore, the digitisation of the information resources expected to be disseminated is a prerequisite for the development of communication relying on web technology.

On January 30, 2018, the National Sports Bureau held the "Digital Sports Training" seminar [9]. While fully understanding the forms and trends of UCI international training, the coaches and researchers at the meeting advocated the implementation of the idea of "science and technology help the Olympic Games", opened new ideas to improve key technologies, and had a deeper understanding of effective digital scientific training, which also reflected the trend of the vigorous development of digital sports in China [3],[6]. On February 25, 2018, the 2017-2018 National Youth Campus Football League (University Group), jointly founded by the Chinese University Sports Association of the Ministry of Education and the Chinese Football Association, and exclusively operated by Alibaba Sports, kicked off its first regional competition [17],[21]. This kind of "digital sports" event operated by enterprises will become a development trend in the future. Since 2018, Ali Sports, University Sports Association and China Sports Association announced to sign a 10-year contract to jointly operate campus sports events [2]. CUFA is the first event to operate after the establishment of cooperation [25]. Ali Sports will guide the leapfrog development of college league matches through the commercial operation of the event, extensive passive and active communication, and science and technology to help sports [24]. It is expected to bring changes to this traditional event. Among them, the intellectualization of events is an important proposition to be completed by Alibaba Sports, which reflects that domestic Internet leading enterprises and domestic universities have also started to develop "digital sports" technology [5].

In recent years, WBAN has received a lot of scholars' attention and research [22]. Wireless body area network is a network composed of wearable or embeddable devices, which communicate through wireless technology [23]. This technology started in the 1990s and developed around the idea of Wireless Personal Area Network (WPAN), which is used to realize wireless communication based on human coordinates [15]. However, the concept of embedded human devices has not appeared in the WPAN stage [12]. With the development of science and technology and the progress of medical technology, human embedded devices for medical use are constantly being developed and designed. In addition to the original human wireless communication, the concept of wireless communication for medical and human health care has gradually been integrated into WPAN, and the concept of WPAN has further developed into a WBAN covering a wider range. Up to now, WBAN is not only used for medical and health care, but also includes motion detection, intelligent environment applications, personal entertainment, and military services [20]. With so many application scenarios and development prospects, WBAN technology has gradually become a hot research direction. As a signal transceiver in WBAN equipment, the antenna for WBAN equipment has also become a hot research direction [11]. As WBAN technology is mainly related to the human body, the antenna for wearable applications working near the human body surface is an important branch of the antenna in the field of WBAN and has crucial research significance and value.

Especially for athletes, monitoring methods should avoid affecting normal training movements. There are many methods for sports posture monitoring. With the development of sensor technology, whether its volume, accuracy and power consumption can be used as a tool for athletes and coaches to provide competition analysis and auxiliary training, and whether it is practical, are all factors that need to be considered for the development of digital sports training.

In response to the current problems of insufficient scientific teaching methods, unclear selection criteria, serious sports injuries and lack of digital resources in domestic sports training, this project measured human posture data with the help of wearable sensor nodes and wireless communication base stations, and developed a software platform to assist in analysingdata and calculating results [10]. After several debugging and testing, the needs of this digital sports training system are basically completed, which can provide solutions for sports training, reduce sports injuries, standardise athletes' movements and help improve training performance [14].

2 RELATED WORK

2.1 Demand Analysis of Digital Sports Training

Since the 1990s, physical education training has gradually started to use technological tools, such as PPT, television video, and computer simulation teaching machines. For example, the proposed digital virtual human model can make up for the teaching deficiencies of traditional methods in human body structure, sports movements, and sports injuries, and the digital virtual human integrated with computer technology can improve the teaching quality of sports anatomy [16]. In the American article analyzing the study of sports injuries, it is mentioned that the study of each sports injury revolves around the prevention and mechanism of the injury, and the athletes' sports career will be more perfect if the mechanism of injury can be prevented as much as possible; at the same time, they also focus on the sports injuries and treatment of adolescents, which also reflects their concern for the future of sports [8]. A master's thesis from Beijing Sports University analyzed the causes of injuries and emphasized the importance of preventing sports injuries [1]. If we can have quantitative parameters for the training of athletes, we can analyze the strengths and weaknesses of each athlete and develop individualized training plans.

2.2 Common Basic Forms in Ultra-Wideband Antenna Design

With the development of dielectric plate printed antennas, a planar biconical antenna emerged, which is often seen in ultra-wideband antenna design as a bow-tie antenna, as shown in Figure 1, in practical applications, the length is limited and the opening angle is not always about 90°. As can be seen from the figure, although the length of the antenna is limited, but its metal part and complementary dielectric part (dashed area) in the region near the feed is still similar, so the bowtie antenna with a certain length is still easy to achieve a wider bandwidth, the input impedance is still about 180Ω. Another familiar plane complementary structure antenna is equal angle spiral antenna, as shown in Figure 2. As can be seen from the figure, like the bowtie antenna, the metallic part (orange in the figure) and the nonmetallic dielectric part (light blue part marked by the curve in the figure) have the same shape and size, and can extend out indefinitely. Therefore, the equal-angle spiral antenna is also an ultra-wideband antenna using the same operating principle, while having an ultra-wide axial ratio bandwidth. The antenna can be excited to work when the two arms are fed with equal amplitude reverse current.

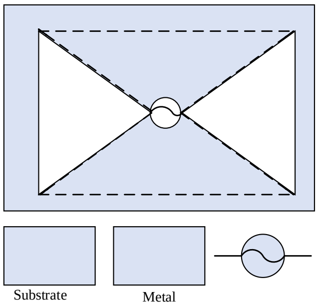


Figure 1: Structural diagram of plane bowtie antenna.

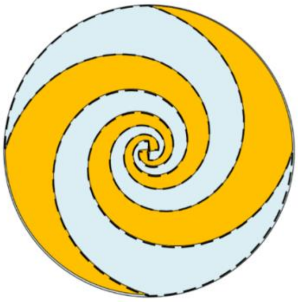


Figure 2: Structural diagram of plane equal angle helical antenna.

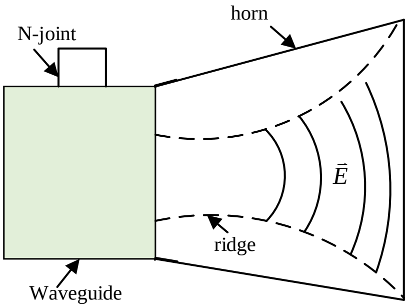


Figure 3: Structural diagram of plane equal angle helical antenna.

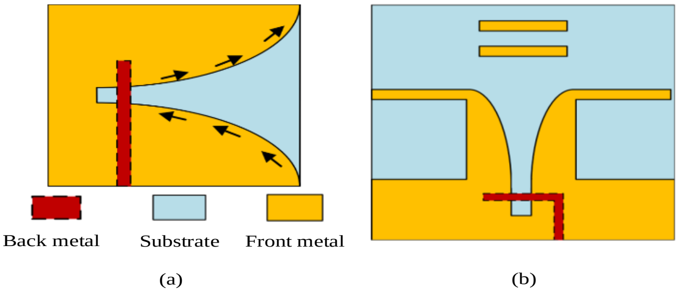


Figure 4: Antenna with gradual structure: (a) vivaldi antenna; (b) plane quasi-yagi antenna.

A gradual ridge is installed on the inner wall of the horn, which can significantly broaden the working bandwidth of the horn. As shown in Figure 3, the narrow gap corresponds to high-frequency electric field radiation, and the wide gap corresponds to low-frequency electric field radiation. This structure is planarized. If the currents on both sides of the ridge are reversed, the electric field can be excited to radiate outward, thus realizing the broadband characteristics, which is the formation process of Vivaldi antenna. As shown in Figure 4 (a), it is a classical Vivaldi antenna fed by microstrip slot coupling. The microstrip line excites a circular magnetic field in the slot, and then the magnetic field will couple a reverse current on both sides of the slot to realize feeding. In the same structure, there is also the widely used planar quasi-Yagi antenna, which ingeniously introduces the gradual structure into the dipole antenna to achieve broadband characteristics, as shown in Figure 4 (b).

2.3 Human Motion Data Monitoring Theory

In the human body model, in order to simplify the complex human structure, the human body is abstracted into several parts, and each part is usually regarded as a rigid body to simplify the complex motion of the human body [1].Commonly used rigid body models are: 17-rigid body model, 16-rigid body model and 14-rigid body model [19]. Obviously, the more rigid bodies in the model, the more the human body's movement can be perfected. In order to study more accurate human motion posture, the 17-rigid body model is used in this project [18]. The 17-rigid body model includes hip, chest, left shoulder, right shoulder, head, left and right upper arm, left and right forearm, left and right thigh, left and right calf hand and foot, and each part of the limbs is connected by joints.Wearable human posture monitoring is to measure the local orientation and angle information of the human body through embedded sensor nodes, which alone cannot measure the posture of the human body, so the subject needs to wear multiple posture sensors on the body to determine the action based on the posture data from multiple sensors. Then, according to the determined 17-rigid body model, each part of the limb needs to wear one sensor node to determine the posture, and the wearing method is shown in Figure 5.

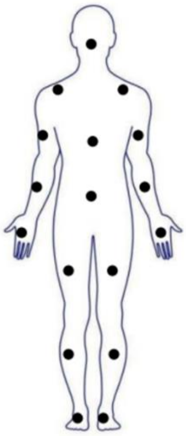


Figure 5: Wearing position of monitoring system multi node.

When wearing the node, pay attention to fixing to ensure that there is no relative movement between the node and the limb. Otherwise, the pose accuracy will be affected.

3 METHODOLOGY

3.1 Structure and Design of Antenna

With the characteristics of easy-to-achieve ultra-wide performance, planar monopole antennas have been popular. In addition, with the development of wireless communication technology, the use of electromagnetic equipment is gradually increasing, and electromagnetic wave components in space are more complex and changeable. To make their communication equipment work normally, the electromagnetic anti-interference performance has gradually become an important index to be considered in antenna design. In the commercial communication frequency band of 3.1 ° 10.6GHz designated by the Federal Communications Commission of the United States, there are many electromagnetic equipment, mainly in the WiMAX (3.3 ° 3.7GHz) and WLAN (5.8GHz) bands, With strong interference, in order to prevent electromagnetic interference of its equipment or interference to other equipment when it acts as a transmitting antenna, the above two band traps are designed into the antenna. To realize the ultra-wideband antenna with small size, very low profile, flexibility and notch characteristics, the monopole antenna fed by coplanar waveguide is adopted in this paper, and combined with the CSRR filter structure, the design is completed.seeFigure 6.

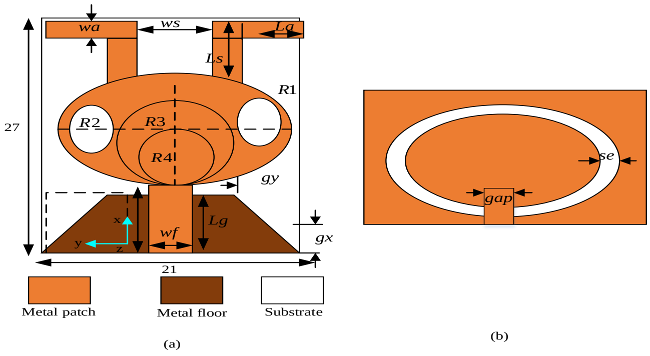


Figure 6: Schematic diagram of uwb antenna structure proposed in this chapter: (a) overall structure; (b) oval single ring CSR.

The UWB monopole antenna with notch characteristics proposed in this paper is shown in Figure 6. The antenna is printed on the FPC1 substrate with a thickness of 0.05mm, the power saving constant εr of the base plate is 3.2, the loss tangent angle 01 is 0. δ, and the single side of the base plate is copper coated (orange part in the figure). The overall size of the antenna is 21mm as shown in the figure × 27mm, relative to the wavelength at 3GHz, Only 0.21 λ 0 ×027 λ 0, The monopole antenna is developed through the rectangular patch monopole antenna in the ordinary form of slitting, deformation, adding nodes, and changing the shape of the floor. By opening circular slots and adding branches on the original rectangular patch, the current path can be changed and increased without changing the original size to achieve miniaturization design. The shape of monopole is changed to introduce gradual structure, reduce the influence of discontinuity, and optimize impedance matching. Changing the shape of the antenna floor is often used to optimize antenna matching in design The height Lg of the floor is 7.25 mm, and the chamfer of the floor is a smooth exponential curve. The coordinate system is established as shown in Figure 6 (a). The curve function of the lower left corner in Figure 6 can be given in Formula (1):

$$E{:}\, x = e_1 \times \{exp[(y - gy) \times e_2] - 1\} + gx \tag{1}$$

Where, the range of y is 0 ≤ y ≤ gy, while e1 and e2 are 1 and 0.305 respectively. The feed part of the antenna is fed by a coplanar waveguide transmission line. To match the 50 Ω SMA connector, the transmission line is designed to have a 50 Ω characteristic impedance. Since the impedance of the coplanar waveguide transmission line is determined by its line width Wf and the slot width S on both sides, the line width Wf is designed as 2.5mm, and S=0.2mm is obtained through calculation and simulation. The dual band notch characteristics of the antenna are realized by using two elliptical single loop CSRR structures. The distance from the center of the circle corresponding to the outer boundary of the two elliptical rings to the bottom of the antenna is expressed as PR3 and PR4 respectively. There are four elliptical structures in the antenna, which are respectively represented as R1, R2, R3 and R4. The size of the elliptical structure is represented by the length parameter of the minor axis and the ratio m parameter of the major axis to the minor axis, respectively. The parameter values of the four elliptical structures are listed in Table 2. The detailed values of other dimension parameters of antenna structure (unit: mm) are listed in Table 1. VSWR parameters and gain of antenna simulation are shown in Figure 7.

parameter	numerical value	parameter	numerical value	parameter	numerical value
wf	2.6	Wa	2	gap_{R3}	1
Lf	8.46	La	5.6	se_{R4}	0.1
S	0.3	Ws	6	gap_{R4}	1
gx	2	Ls	8	P_{R3}	13.5
gy	6	se_{R3}	0.3	P_{R4}	12

Table 1: Various size parameters of uwb monopole antenna with notch characteristics (unit: mm).

ellipse	R1	R2	R3	R4
Stub shaft	8	2.7	6	3.4
m	1.6	1.34	1.26	1.3

Table 2: Size parameters of elliptical ring in antenna proposed (unit: mm).

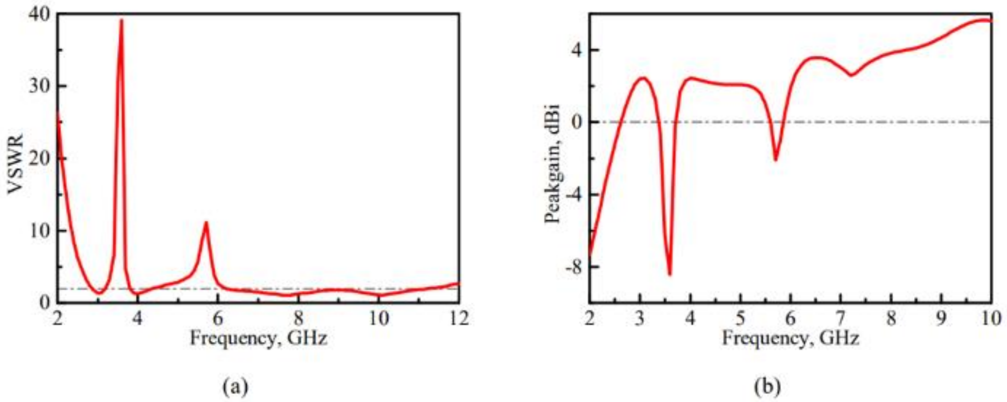


Figure 7: Simulation results of antenna proposed in this chapter: (a) V SWR; (b) peak gain.

3.2 Overall Hardware Design Framework

There are two communication modes for monitoring system hardware: one is 5G communication mode, and the other is Wi-Fi communication mode. 5G communication means that the node transmits data to the transmission base station via a wireless module and then uploads data to the server via the 5G module in the base station. Wi-Fi communication means that the data is transmitted to the client via Wi-Fi in the local area network. Both methods ensure real-time performance and are not limited by the site environment. The topology relationship between base stations and nodes is shown in Figure 8(a). The second is the Wi-Fi communication mode, as shown in Figure 8(b), where a router is used to generate a LAN and several nodes and clients can communicate within the LAN.

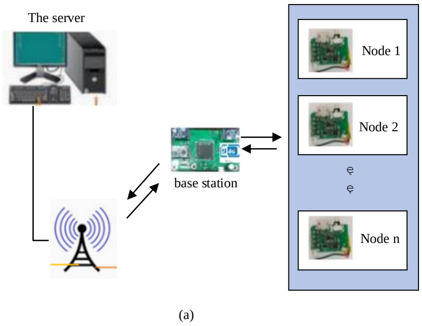


Figure 8: Hardware communication topology (a) 4g communication.

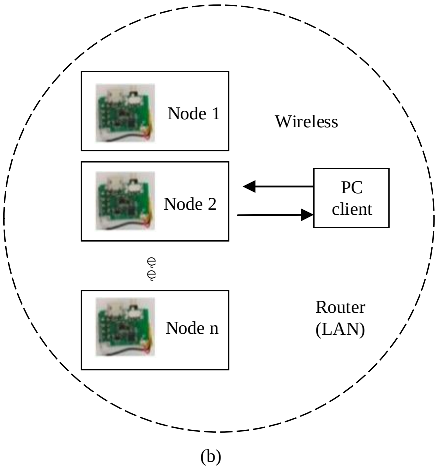


Figure 8: (continued) Topology diagram of hardware communication mode (b) WIFI communication mode.

3.2.1 Node Hardware Composition

When designing wearable sensor nodes, two factors must be considered: one is the weight of the node, and the other is the power consumption of the sensor to ensure that sufficient endurance will not affect the movement attitude of the measured person. The node device is divided into seven units, namely, battery unit, charging unit, power management unit, master control unit, attitude measurement unit, wireless communication unit, and node configuration unit. The node structure block diagram is shown in Figure 9.

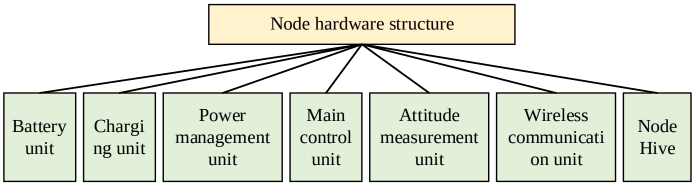
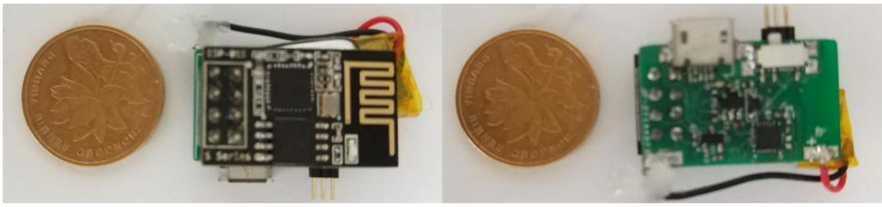


Figure 9: Block diagram of node structure.

The size of the node is about 1 * 2.5cm, the physical weight is less than 30g, a complete charge takes about 20 minutes, and the battery life is about 3 hours. The physical picture is shown in Figure 10.



(a) (b)

Figure 10: Physical view of node (a) front of node (wireless transmission circuit) (b) back of node (sensor measurement circuit).

3.2.2 Hardware Composition of Base Station

The transmission base station is composed of power management unit, wireless communication unit, master control unit, data upload unit and base station configuration unit. The main function of the base station is to use the wireless communication unit to receive the data sent by the node, summarize, and process it, and then transmit it to the PC through USB. The composition block diagram and physical diagram of the base station are shown in Figure 11 - Figure 12

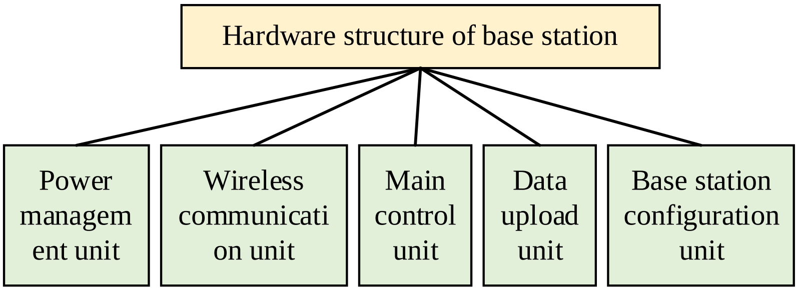


Figure 11: Block diagram of communication base station.

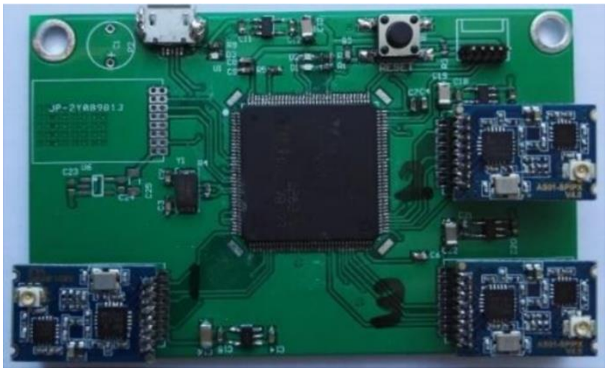


Figure 12: Physical map of base station.

3.3 Overall Structure of Software Platform

This software platform has several major functions: first, it cooperates with hardware devices to collect motion posture data; second, it stores and queries data; third, it embeds 3D scene plug-ins to display and replay motion scenes; fourth, it analyzes and processes key parameters. The function of the cloud server is to provide data services for the client, conduct overall analysis of multiple user data, and ensure data security and network security. The sports training software platform can be divided into four modules according to functions: real-time collection, 3D scene, user and equipment information management, data analysis and processing. It also includes background servers for data service and data security. The structure of the software platform divided by function is shown in Figure 13.

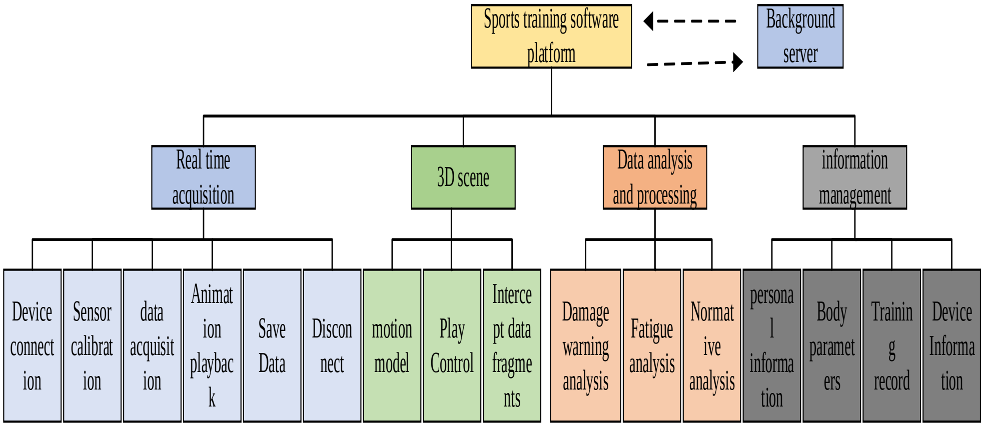


Figure 13: Software platform structure block diagram.

4 EXPERIMENTS

4.1 Antenna Processing and Test Results

In order to verify the rationality of the antenna design idea in this paper and the correctness of the antenna simulation results, we processed and tested the final proposed antenna as the prototype, and the entire antenna was printed at 21mm × 27mm × 0.05mm FPC § 1 medium soft board. First, it can be seen from the processing object of the antenna that the antenna has only a small size of about 20mm in width, which is very compact and convenient for its application in a variety of scenarios as a tag antenna. To more intuitively display the notch characteristics of the monopole antenna, the measured standing wave ratio VSWR is given here in place of the reflection coefficient, and the test results are put together with the simulation results in Figure 14, and the actual normal gain curves of the test and simulation are drawn in another Figure 15. In addition, as shown in Figure 14, the impedance bandwidth of VSWR<2 tested is 3-10.1GHz, and the standing wave ratio performance at high frequencies is slightly worse than the simulation results, making the overall impedance bandwidth obtained from the test results slightly smaller than the simulation results. The reason for this result may be that the size of the antenna is too small, and the size of SMA connector is about 10GHz, which is equivalent to the wavelength, and its introduction has some influence on the performance of the antenna.

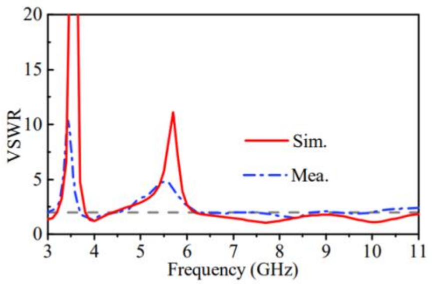


Figure 14: Comparison of VSWR results of test and simulation.

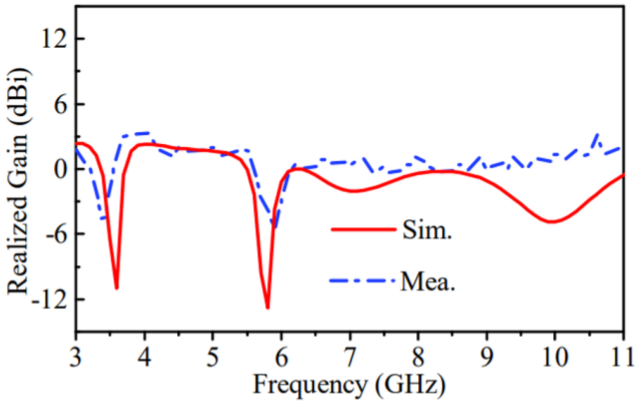


Figure 15: Comparison diagram of normal gain curves of test and simulation.

In addition, note that the notch characteristics of VSWR>3 are realized at 3.3-3.6GHz and 4.9-5.9GHz, respectively, within the working bandwidth; the maximum standing wave ratio is 10.57 and 4.8 at 3.45GHz and 5.55GHz, respectively. These frequency bands correspond to WiMAX and WLAN communication frequency bands. However, it is noted that the second notch obtained from the test results in the WLAN communication frequency band has shifted to the low frequency by nearly 250MHz compared with the simulation results (the maximum VSWR of 11.1 occurs at 5.7GHz), which may be attributed to the narrow slot width of the CSR R that realizes the 5.8GHz notch and is more sensitive to processing errors and the dielectric constant of the substrate. In addition, in the actual test, the standing wave ratio of the antenna starts to be less than 2 at 2.3GHz, and the size of the antenna at this frequency is 0.2 relative to the wavelength λ × zero point one seven λ, It shows that the antenna has a good miniaturization size. Figure 15 shows the actual gain change curve of the normal direction of the antenna plane in the ultra-wideband frequency band of 3-11GHz, including the test and simulation results. It can be clearly seen from the figure that the test curve has two sharp dips in the observed frequency band, the gain drops below 0dBi in the 3.3-3.6GHz and 5.6 °6.1GHz frequency bands respectively, and the gain reaches the minimum value at 3.5GHz and 5.9GHz respectively, which is μ 5.24dBi and μ 5.5dBi. Compared with the simulation results, two minimum values in the frequency band are obtained at 3.6 GHz and 5.8 GHz respectively, showing good consistency. It shows that the two CSR structures on the antenna can achieve filtering characteristics well and accurately at the frequency without additional filtering circuits at the target frequency point.

4.2 Wearable Device Realization and Result Analysis

After defining the function, the function of each module shall be designed in detail to meet the requirements of the software platform. This paper introduces the block diagram of some main functional modules in the sports training system software platform. The functional block diagram of the real-time acquisition module is shown in Figure 16.

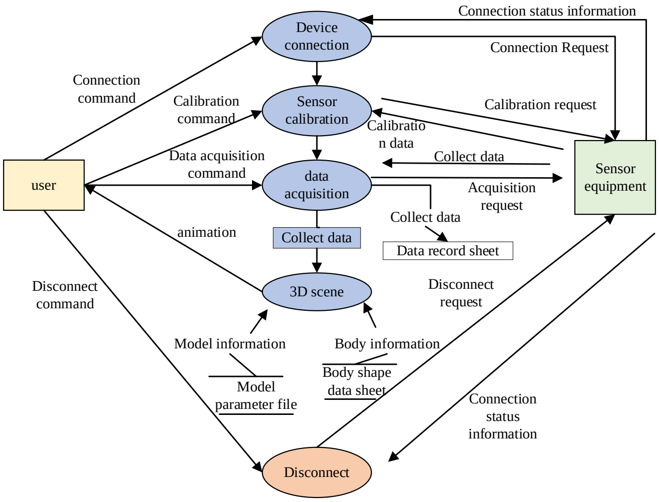


Figure 16: Functional block diagram of real-time acquisition module.

The real-time acquisition module connects the client with the sensor device. Before data acquisition, some preparations should be made: the user sends the connection command to confirm the connection status information, Then sends the sensor calibration command because slight changes in the initial position will affect the accuracy of the measurement, and confirm the calibration through the interface button. After completing these tasks, you can start data collection, and the collected data will be sent to Unity3D scene control in real-time. Corresponding actions can be made synchronously according to the calibrated action manikin, and the collected data can be saved at the same time. The real-time acquisition interface is shown in Figure 17.

Figure 17: Real time monitoring and 3d scene.

The 3D scene module is embedded in the real-time acquisition page, and the human body model is built using the default model or according to the measured athlete's model parameters and body shape parameter data. The 3D scene control is also used in the record and play page, which can reproduce the human motion track, slide to change the view angle and rotation, and can also realize playback, slow playback, capture of data clips, and action comparison. The functional block diagram of user information management is shown in Figure 18. The user information includes the personal information, body shape information, measured record data, and measured index data obtained from analysis of the athletes and coaches. These data are stored and managed by the local database. Specific functions include: adding users, searching users, deleting users, searching user information and records; Add data records, search records, delete records, etc.; Control 3D scene space to play corresponding data records[26].

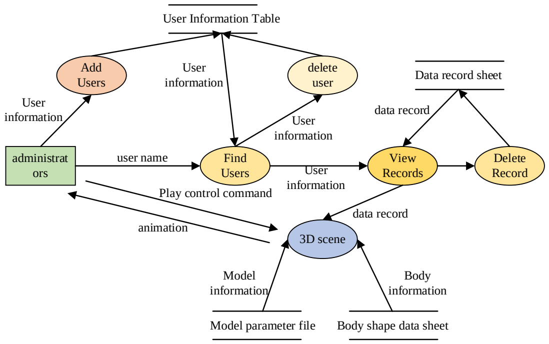


Figure 18: Functional block diagram of user information management.

4.2.1 Joint Injury Early Warning Analysis

When measuring the range of pronation/supination, pay attention to binding the sensor node to the fixed position of the forearm. The rotation angle of different positions should be different. The curve of normal range of motion of the elbow joint measured is shown in Figure 19.

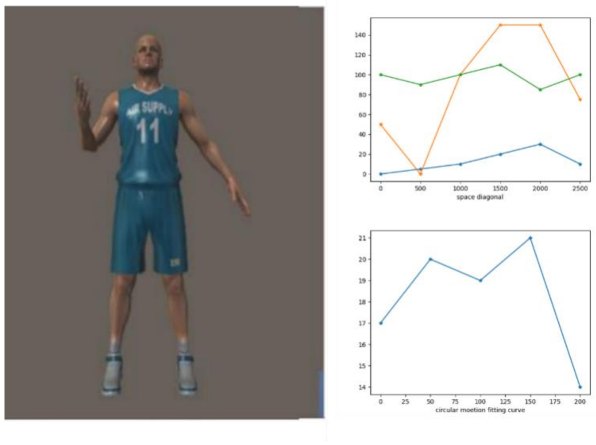


Figure 19: The page of the elbow normal range calibration（a）flexion and extension.

During the experiment, the plane formed by the ulna and radius close to the wrist joint is selected as the measuring point. With respect to the initial position of the human body, its pronation/supination range is about as shown in Figure 19 (a) $-50^{\circ} < \varphi < 90^{\circ}$

4.2.2 Analysis of Action Standardization

The following conclusions can be drawn from the figure: it is difficult to observe the subtle differences of human actions and animations visually. Once the sports training data are quantized, the differences between real-time actions and standard actions can be easily observed. From the space angle curve, we can analyze which action is not in place, and further find out the reason for non-standard action according to the physiological structure. For example, the leg angles of the jumping and landing movements monitored in the figure are slightly different when landing. Limb 1 is a thigh action, limb 2 is a calf action, and 1 1 1 (,) $\omega\theta\varphi$, 2 2 2 (,) $\omega\theta\varphi$ represent the space angle curves of record 1 and record 2 of two data files respectively, Record 1 is the standard action. It can be seen from the figure that the angle between the landing leg and the ground in record 2 is large, so it can be judged that the position of the weight center of the athlete's landing is not adjusted well. In the actual triple jump, the normative analysis page of a jump is shown in Figure 20.

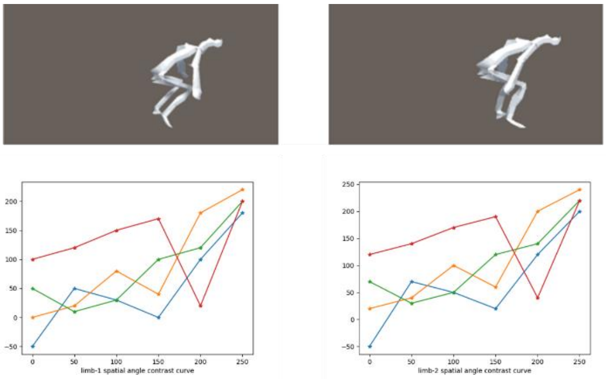


Figure 20: Normative analysis page of one jump in triple jump.

The main content of this chapter is the design and implementation of the sports training software platform: firstly, it introduces the overall design framework of the software platform and the functions that need to be realized, secondly, it shows the completion of the client interface of the software platform, which includes the design and implementation method of 3D scenes and other contents, then it introduces the database of this software platform about the storage method of data information, and briefly describes the performance of the background server framework and The server construction process is briefly explained. Finally, this software platform is used to calculate and analyze the characteristic parameters for joint damage warning and normality of movement.

5 CONCLUSION

To address the current problems of insufficient scientific teaching methods, unclear selection criteria, serious sports injuries, and lack of digital resources in domestic sports training, this project measured human posture data with the help of wearable sensor nodes and wireless communication base stations, and firstly studied the antenna ultra-wide band technology in 5G key technology. Starting from the most basic planar monopole structure, the proposed monopole antenna is processed and tested. The test and simulation results show good agreement with good filtering characteristics and ultra-bandwidth, and still work effectively in a reasonable bending range. With the support of communication technology, we designed a software platform for sports training. We show the completion of the client interface of the software platform, including the design and implementation of 3D scenes, and describe the performance of the backend server framework and the process of server construction. The software platform calculates and analyzes the parameters of joint injury warning and normative features of actions. After several debugging and testing, the requirements of this digital sports training system are basically completed, which can provide solutions for sports training, reduce sports injuries, standardize athletes' actions, and help improve training performance. Although I have done some research work on 5G UWB communication technology and wearable devices for sports training data management and achieved some results, there are still some shortcomings and shortcomings that still need to be further accomplished in subsequent work. 1) Further improve the energy effective strategy of the system, focusing on the similarity detection of human features, based on which the data transmission can be more effectively reduced and computational effort. Future work will need to investigate corresponding methods to save the system's energy according to this aim. 2) The whole experimental platform still has some limitations in terms of comfort, charging time and stability of hardware equipment during actual use, and future work will need to make further improvements in the above aspects according to actual needs. The integration of Virtual Reality solutions, 5G Ultra-Wideband communication technology, and wearable devices marks a paradigm shift in sports training data management. This innovative approach offers a holistic and immersive solution, addressing the evolving needs of athletes and coaches. By leveraging VR for realistic simulations, 5G UWB for high-speed data communication, and wearables for real-time performance monitoring, the synergy of these technologies transforms the landscape of sports training.

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